Asset Management and Condition Monitoring
The Whole System Is Greater Than Its Parts

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According to the U.S. Department of Commerce, process and manufacturing plants spend as much as 40 percent of revenues on maintenance. *Control Magazine* (October 1996) estimates that manufacturers worldwide spend USD 69 billion on maintenance each year. In petrochemical and petroleum refining plants, up to 10 percent of production capacity is said to be required to make up for unplanned maintenance.

An asset management system's life-cycle cost is negligible relative to the cost of maintaining process plants and the lost production due to unplanned equipment outages. Return On Investment (ROI) is often measured in the range of ten times the cost and higher. The benefits of implementing an effective asset management system have strong economic justification. However, potential users are confused about asset management systems and are reluctant to implement them because vendor claims so often conflict. As a result, this market segment has been slow to develop.
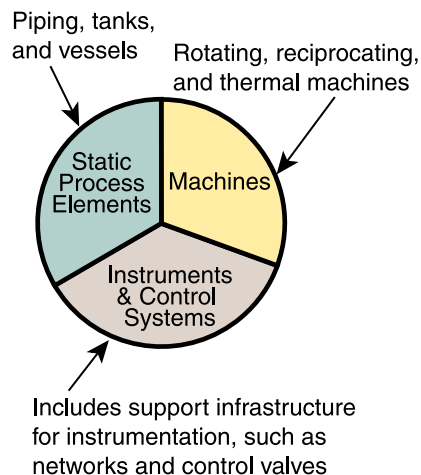
Many claim they provide complete asset management solutions, but the functionality of their systems varies greatly, as does the scope of assets they support. One vendor offers an instrumentation-focused asset management solution, while another vendor's product is for plant equipment. Some state that asset management is specific to the maintenance process while others insist that it is primarily based on fault diagnostics capabilities. Amid the variety, users struggle to find the best approach and determine the tools they need.

Which Assets?

Production plant Operations and Maintenance personnel are focused on *critical production assets* – those that can affect the plant's immediate ability to make products. As this class of assets is the plant's focus, it should be encompassed in the scope of assets supported by asset management systems.

Critical production assets include but are not limited to:

Piping, tanks, and vessels

Rotating, reciprocating, and thermal machines

Static Process Elements

Machines

Instruments & Control Systems

Includes support infrastructure for instrumentation, such as networks and control valves

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How Do You Manage an Asset?

Effective management of critical production assets requires a number of systems and technologies, including:

- Controlling and documenting the operations and maintenance processes and resources;
- Monitoring the health and performance of critical production assets to determine if the mode of operation should be changed or when maintenance is required;
- Collecting and generating metrics that help measure the reliability of assets so the production process, maintenance practices, and plant design can be optimized;
- Managing documentation for operation and maintenance of these assets;

- Disseminating information that enables Operations and/or Maintenance personnel and automation systems to make decisions on the operation and maintenance of these assets in real time; and

- Interfacing to enterprise-level applications, such as procurement, market demand, human resource, and supply chain management, that are required to support these assets.

Operations and Maintenance Have Different, Yet Related, Needs

Operations and Maintenance are both users of asset management systems, but they each focus on different aspects and information sets of the systems. Operations wants to *identify and correct problems in a real-time process environment*, allowing for maximum production potential of the plant. Maintenance wants to *automate its processes* to increase efficiency and thereby lower its costs.

Operations needs to focus primarily on Actionable Information℠ to make timely decisions about the operation of assets for maximized plant throughput. Actionable Information is a set of information that *recommends a course of action* to the Operations (or Maintenance) user on how to proceed when an "event" has occurred.

Maintenance needs both Decision Support℠ (to automate the process of fault diagnosis) and Actionable Information to expedite the correction of asset faults. Decision Support is a tool that *provides automated fault diagnosis along with fault severity.*

Bently Nevada's Decision Support product is called Machine Condition Manager™ 2000 (MCM2000). MCM2000 is a rule-based system that includes

predefined machinery faults and Actionable Information as well as the ability to incorporate custom rule sets and customer-defined Actionable Information. Customers can add their own specific requirements to the rule set, so that it becomes specific to their plant. It also supports interfaces to automation products such as maintenance management systems. MCM2000 has evolved over the past five years to become the industry-leading machinery "expert system," with installations worldwide.

Maintenance management systems provide value by effectively scheduling maintenance resources, in order to limit unplanned outages due to poorly maintained equipment and thus avoid lengthy turn-arounds. *They do not, however, effectively assess asset condition*. Though most maintenance management systems can react to asset condition-based alarms, they do not typically generate these alarms. Maintenance management systems are *reactive* tools, focused on the maintenance processes and not asset condition. They are required to optimize the maintenance process. In contrast, condition monitoring systems are required to diagnose equipment malfunctions.

The condition and performance monitoring aspects of asset management systems are often poorly understood. Most asset management vendors focus primarily on a single asset type (e.g., instrumentation) or on one aspect of management (e.g., the maintenance process). The effectiveness of these systems is limited by their narrow scope, even though they may be effective within that scope.

Asset management can only optimize critical production assets if it includes *all* aspects of management and *all* types of assets. A maintenance

management system that does not have access to asset condition information may increase maintenance efficiency, but it does not help users to decide *when* condition-based maintenance is needed, *what* the asset fault is, or *if* an asset needs to be taken out of service. Without fault diagnostics and identification, maintenance management systems can only react to an alarm that indicates a fault has occurred. Alone, they cannot minimize the potential of lost production nor maximize the health of the asset.

Asset management vendors that focus their solution on the maintenance management process often include modules that claim to provide condition-based monitoring. In most cases, this functionality is not really "condition-based monitoring," but is instead "event-based maintenance." These vendors are reacting to level alarms and not fault identification. It is important to understand this distinction.

Decision Support℠ Systems

Bently Nevada's Decision Support systems can provide information that addresses the concerns of production management *and* directs asset management systems toward *proactive* condition and performance-based

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maintenance and operation. Decision Support℠ systems are capable of assessing the condition of assets and transmitting Actionable Information℠ to appropriate individuals and systems *in a form that lets Operations and Maintenance make collaborative decisions* that optimize both Operations and Maintenance performance.

Dividing Decision Support into automated diagnosis of asset faults and Actionable Information provides the key data that enables *optimized decisions*. Decision Support systems identify *what is wrong* with an asset and *what action* should be taken to resolve a problem. This helps both Operations and Maintenance to optimize asset management rather than simply introducing automation.

To understand the difference between automating *administration* and

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With Decision Support℠

Asset fault

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Automated fault diagnosis with Decision Support℠

↙ ↘

Process change   Repair

↘ ↙

Problem resolved

Time in hours

Without Decision Support℠

Asset fault

↓

Instrument inspection

↓

Mechanical inspection

↓

Data acquisition

↓

Data analysis

↓

Fault diagnosis

↙ ↘

Process change   Repair

↘ ↙

Problem resolved

Time in days

optimization of asset management, we can examine rotating and reciprocating machinery, a segment of critical production assets and a major focus of Bently Nevada's products and services. Machine Condition Manager™ 2000 (MCM2000), Bently Nevada's Decision Support system, is focused on machinery assets. Automated fault diagnosis and
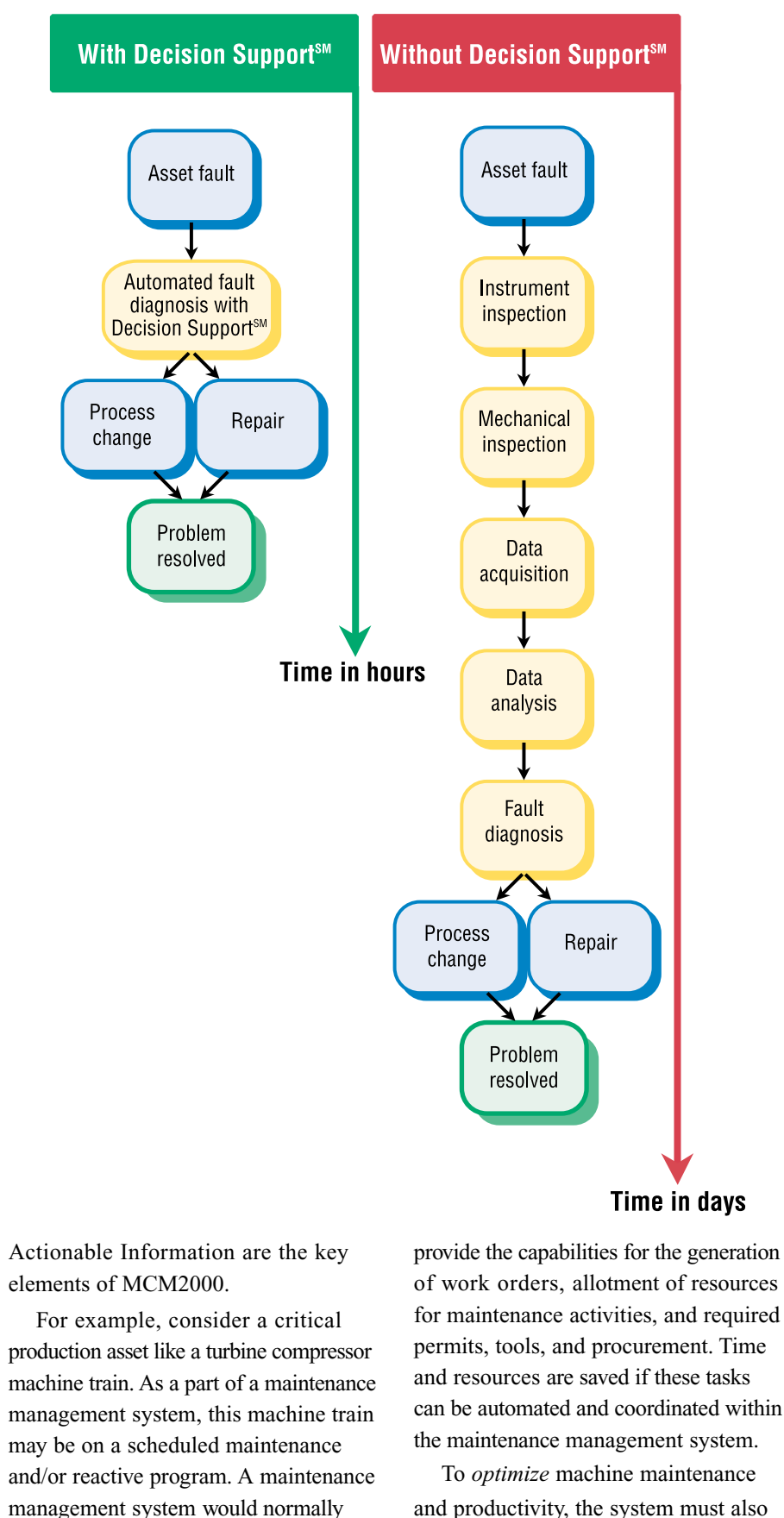
Actionable Information are the key elements of MCM2000.

For example, consider a critical production asset like a turbine compressor machine train. As a part of a maintenance management system, this machine train may be on a scheduled maintenance and/or reactive program. A maintenance management system would normally

provide the capabilities for the generation of work orders, allotment of resources for maintenance activities, and required permits, tools, and procurement. Time and resources are saved if these tasks can be automated and coordinated within the maintenance management system.

To *optimize* machine maintenance and productivity, the system must also

act proactively and be able to identify asset malfunctions as well as the recommended actions to correct such malfunctions.

A "High Vibration" alarm, for example, only indicates that there has been a machine event. In a maintenance management system, this alarm means that a work order is generated for an inspection. The system automates work

order generation, but does little to immediately identify and resolve the problem itself. After the instrumentation and machine train are inspected, Maintenance must collect and analyze asset condition data and identify the cause of the malfunction. This can take days.

Immediately taking the machine out of service for condition assessment and/or repair may or may not be in the best interest of Operations. Alternatively, leaving a malfunctioning machine in service can lead to a catastrophic failure that could likely increase maintenance cost and result in lost production. Maintenance and Operations want to *know what the fault is* and *its severity* before a decision is made whether to shut the machine down or let it run. Also, Maintenance and Operations must determine how to correct the problem to keep the machine online or

minimize the downtime should it be required to take it out of service. Without Decision Support℠ and Actionable Information, users have very limited data on which to base potentially costly decisions.

With Decision Support, Operations knows what the problem is along with its level of severity. Instead of a "High Vibration" alarm, Maintenance gets information on a specific fault, such as severe fluid instability in a bearing. This is very serious and must be corrected at once, or the machine should be taken out of service. Operations receives the same information about the fault and also receives *Actionable Information℠*, which indicates that changing lubricating fluid temperature and/or pressure might solve the problem. Here, plant personnel learn *exactly what is wrong*, the *severity of the problem*, and *a recommended course of action*. In many cases, Decision Support and Actionable Information mean that the unit can stay online. *The problem is solved in minutes or hours instead of days*. Savings (by avoiding the costs of lost production and repair) for a single event can pay for an asset management system several times over.

An asset management program that *optimizes*, not just automates, a production facility, should include *all* production assets. It should incorporate the significant asset management technologies, including both condition and performance monitoring. At present, asset management is a "best of breed" integrated solution, due to the breadth of functionality required. The integration of these systems must be approached with both Operations and Maintenance

users in mind, to maximize the effectiveness of all systems.

Asset management can be optimized to assist both Operations and Maintenance personnel. The cost is negligible compared to the shutdown of production because of a machine failure or malfunction. Bently Nevada can provide comprehensive services to assist customers:

• in assessing their needs;
• in designing individualized condition monitoring systems;
• by recommending asset management system design and components;
• in integrating and implementing systems and programs;
• and by training personnel to fully utilize the systems in place.

We have been providing such services worldwide for many years, beginning with our eddy current proximity transducers 45 years ago, followed by constantly improved products and services based on customer feedback. [Editor's Note: A continued discussion of this topic will appear in the Third Quarter 2000 ORBIT, as a *From the Desk of* article by Roger Harker.] For more information on MCM2000 and other related products and services, please contact your nearest Bently Nevada sales or service professional, or visit our web site at www.bently.com.